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METHOD FOR COMPRESSION MOLDING
[ASSHUKU SEIKEI HOUHOU]

MAKOTO ETO, ET AL.

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INVENTOR(S)	(72):	MAKOTO ETO KIYOSHI KAWAGUCHI
APPLICANT(S)	(71):	YASUNAGA KUWABARA
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Specification

1. Title of the Invention

Method for Compression Molding

2. Scope of Claim(s)

1. A method for compression molding being characterized in that it comprises arranging, in the vertical direction below an extrusion hole of an extruder having said extrusion hole opened downward in the vertical direction, a transferring means having a receiving space opened upward in the vertical direction by substantially matching the central axes of said extrusion hole and said receiving space extending substantially vertical with one another; extruding a molten synthetic resin through said extrusion hole of said extruder, detaching it from said extrusion hole, and positioning it below said extrusion hole; bringing a compression mold having a male mold portion facing upward and a female mold portion facing downward into an opened state by separating said male mold portion and said female mold portion in the vertical direction, positioning said transferring means accommodating a molten synthetic resin inside said receiving space, and matching the central axes of said receiving space and said male mold portion extending substantially vertically with one another downward below said male mold portion in the vertical direction; bringing said transferring

means and said male mold portion relatively close to one another in the vertical direction, forcing the molten synthetic resin accommodated inside said receiving space into said male mold portion, then relatively separating said transferring means and said male mold portion in the vertical direction to thus adhere the molten synthetic resin accommodated inside said receiving space of said transferring means to said male mold portion; and bringing said male mold portion to which the molten synthetic resin was adhered and said female mold portion relatively close in the vertical direction, and compression molding the molten synthetic resin into a predetermined shape.

2. The method for compression molding as cited in Claim 1 wherein

/2

the average centerline roughness R_a of at least a portion of said transferring means of the surface defining said receiving space is greater than that of the surface of said male mold portion.

3. The method for compression molding as cited in Claim 2 wherein blasting is conducted on at least the portion of said surface of said transferring means defining said receiving space.

4. The method for compression molding as cited in Claim 3 wherein the average centerline roughness R_a of at least the portion of said surface of said transferring means defining said

receiving space is 0.5 to 3.5.

5. The method for compression molding as cited in any of Claims 1 to 4 wherein the surface of said transferring means where said receiving space is defined has a shape at least partially matching that of the surface of said female mold portion of said compression mold where the molding cavity is defined.

6. The method for compression molding as cited in any of Claims 1 to 5 wherein the temperature of the surface of said transferring means defining said receiving space is controlled to 10 to 50°C.

7. The method for compression molding as cited in any of Claims 1 to 6 wherein, while supplying the molten synthetic resin to said receiving space of said transferring means, the lower end of the molten synthetic resin extruded through said extrusion hole comes in contact with the surface defining said receiving space, after which said molten synthetic resin is detached from said extrusion hole.

8. The method for compression molding as cited in any of Claims 1 to 7 wherein, while extruding the molten synthetic resin through said extrusion hole and supplying it to said receiving space of said transferring means, said transferring means is moved relative to said extrusion hole in the vertical direction.

9. The method for compression molding as cited in any of Claims 1 to 8 wherein the molten synthetic resin extruded through said

extrusion hole contains an inside synthetic resin layer and an outside synthetic resin layer surrounding at least the flank of this inside synthetic resin layer.

3. Detailed Description of the Invention

(Technical Field)

The present invention relates to a method for compression molding, and more specifically, to a method for compression molding in which a molten synthetic resin is extruded through the extrusion hole of an extruder and separate from the extrusion hole, this molten synthetic resin is supplied to a compression molding mold and compression molded into a predetermined shape.

(Prior Art)

As is well-known by persons skilled in the art, a so-called pre-form blow-molded and made into containers made of synthetic resins for foods and beverages and so forth, or final products, such as the containers themselves made of synthetic resins or container lids, that are compression molded instead of injection molded are starting to be proposed and used practically.

In this compression molding, a molten synthetic resin is extruded through the extrusion hole of an extruder, the extruded molten synthetic resin is cut by an appropriate cutting means, such as a rotary cutting blade, the cut molten synthetic resin is supplied to a compression mold, then this molten

synthetic resin is compression molded into a predetermined shape inside the compression mold. In general, the extruder is disposed so that the central axis of the extrusion hole thereof extends substantially horizontally, the female mold portion of the compression mold is positioned below the extrusion hole, the molten synthetic resin extruded through the extrusion hole flows downward by its own weight, and at the same time, forced downward by the action of the cutting means, and thus is supplied into a female mold portion of the compression mold.

On the other hand, it is disclosed in Japanese unexamined patent application publication no. S62-184817 that a multilayer structured molded product is obtained by compression molding a multilayer structured molten synthetic resin containing an inside synthetic resin layer and an outside synthetic resin layer surrounding it. It is convenient that the inside synthetic resin layer comprises a synthetic resin outstanding in gas barrier properties or heat resistance and that the outside synthetic resin comprises a synthetic resin outstanding in mechanical properties or hygienic properties.

/3

(Problems of the Prior Art)

Thus, in the conventional method for compression molding, the molten synthetic resin cannot be supplied sufficiently or satisfactorily to a predetermined position of the compression

mold, i.e., the center portion, and the molten synthetic resin supplied to the compression mold tends to be disproportionately situated. This tendency generates a serious problem especially when the molten synthetic resin has a multilayer structure. That is to say, when the multilayer structure molten synthetic resin is disproportionately supplied into the compression mold, the inside synthetic resin layer and outside synthetic resin layer are maldistributed, and the technical ideal of the multilayer structure is markedly compromised.

(Related Art)

To solve the problems above in the prior art, the inventors of the present invention previously proposed a unique, improved method for compression molding (hereinafter called “related method for compression molding”) in the Specification and drawings of Japanese Patent Application No. S63-286801 (application date: November 15, 1988, Title of the Invention: Method for Compression Molding). In this related method for compression molding, an extruder is disposed by extending the central axis of the extrusion hole thereof substantially vertically and opening the extrusion hole thereof downward in the vertical direction. A transferring means whose central axis extends substantially vertically and is provided with a receiving space opened upward in the vertical direction is situated vertically below the extrusion hole. This transferring

means has a form wherein it can be set selectively in a closed state able to accommodate the molten synthetic resin inside the receiving space and an open state wherein the molten synthetic resin drops downward into the receiving space. The molten synthetic resin is extruded through the extrusion hole of the extruder; the extruded molten synthetic resin is detached from the extrusion hole, and supplied into the receiving space of the transferring means set in a closed sate. The transferring means accommodating the molten synthetic resin is placed vertically above the female mold portion that is isolated from the male mold portion vertically below it. Next, the transferring means is brought into an open state and the molten synthetic resin accommodated inside the receiving space thereof drops down and is transferred to the female mold portion. The molten synthetic resin is compression molded into a predetermined shape by bringing the male mold portion close to female mold portion into which the molten synthetic resin was transferred.

(Problems of the Related Art)

According to the related method for compression molding above, maldistribution of the molten synthetic resin inside the compression mold can be substantially improved over the conventional method for compression molding. However, according to testing performed by the inventors of the present invention, it was proven that the above-mentioned related method for

compression molding could not be made satisfactory enough yet, and had the following problems:

Firstly, when the transferring means is brought into the open state in particular and the molten synthetic resin drops into the female mold portion from the receiving space thereof, the molten synthetic resin is caused to not withdraw uniformly enough from the transferring means along the entire circumferential direction, and the molten synthetic resin drops somewhat disproportionately into the female mold portion; hence, the problem of the maldistribution of the molten synthetic resin in the compression mold remains without being satisfactorily solved.

Secondly, a considerable crease tends to develop on the surface of the compression molded product as the molten synthetic resin that dropped into the female mold portion adheres to the male mold portion in a state in which air somewhat gets trapped between the surface of the female mold portion and the molten synthetic resin, and this trapped air is compressed without being able to escape.

(Problems to Be Solved by the Invention)

The present invention was accomplished in view of the above circumstances, and the main technical objective thereof is to improve the supply system for the molten synthetic resin to the compression mold, enable a sufficient and satisfactory supply of

the molten synthetic resin to a predetermined position of the compression mold, and thus solve the above problems of the related method for compression molding along with the above problems of the conventional method for

/4

compression molding.

(Means for Solving the Problems)

As a result of intensive research and testing, the inventors of the present invention discovered that the above-mentioned technical objective could be achieved by adding an improvement by: (1) situating the transferring means supplying the molten synthetic resin into the receiving space below the male mold portion in the vertical direction; and (2) bringing the transferring means and male mold portion relatively close in the vertical direction, then relatively separating the transferring means and male mold portion in the vertical direction to thus adhere the molten synthetic resin accommodated in the receiving space of the transferring means to the male mold portion.

Namely, according to the present invention, a method for compression molding being characterized in that it comprises:

Arranging, in the vertical direction below an extrusion hole of an extruder having the extrusion hole opened downward in the vertical direction, a transferring means having a receiving space opened upward in the vertical direction by substantially

matching the central axes of the extrusion hole and the receiving space extending substantially vertical with one another;

Extruding a molten synthetic resin through the extrusion hole of the extruder, detaching it from the extrusion hole, and positioning it below the extrusion hole;

Bringing a compression mold having a male mold portion facing upward and a female mold portion facing downward into an opened state by separating the male mold portion and the female mold portion in the vertical direction, positioning the transferring means accommodating a molten synthetic resin inside the receiving space, and matching the central axes of the receiving space and the male mold portion extending substantially vertically with one another downward below the male mold portion in the vertical direction;

Bringing the transferring means and the male mold portion relatively close in the vertical direction, forcing the molten synthetic resin accommodated inside the receiving space into the male mold portion, then relatively separating the transferring means and the male mold portion in the vertical direction to thus adhere the molten synthetic resin accommodated inside the receiving space of the transferring means to the male mold portion; and

Bringing the male mold portion to which the molten synthetic

resin was adhered and the female mold portion relatively close to one another in the vertical direction and compression molding the molten synthetic resin into a predetermined shape is provided.

Since the molten synthetic resin forced into the male mold portion withdraws from the receiving space of the transferring means reliably so as to adhere to the male mold portion while relatively separating the transferring means and male mold portion in the vertical direction, it is preferred that by conducting blasting on at least the portion of the surface of the transferring means defining the receiving space., the surface roughness thereof be relatively large, e.g., an average centerline roughness R_a is set to about 0.5 to 3.5, and thus, the adhesive power between the surface defining the receiving space and the molten synthetic resin be reduced. Moreover, it is ideal that the surface of the transferring means defining the receiving space have a shape at least partially matching that of the surface of the female mold portion of the compression mold where the molding cavity is defined, and moreover, the temperature be controlled to 10 to 50°C.

(Effect of the Invention)

In the method for compression molding of the present invention the transferring means and male mold portion are brought relatively close in the vertical direction and the

molten synthetic resin inside the receiving space of the transferring means is forced into male mold portion forcibly. Hence, the molten synthetic resin can be transferred to the male mold portion from the receiving space of the transferring means, and therefore to the compression mold without transverse displacement. When being transferred to the male mold portion from the receiving space of the transferring means, the molten synthetic resin is forced into the male mold portion; hence, the risk of air, which cannot escape, being trapped between the surface of the male mold portion and the molten synthetic resin

/5

is substantially eliminated.

(Preferred Specific Examples of the Invention)

The preferred specific examples of the present invention will now be described in detail with reference to the appended drawings.

Figure 1 is illustrates a simplification of the compression molding apparatus used to perform the preferred specific examples of the method for compression molding in accordance with the present invention. The illustrated compression molding apparatus comprises an extruder 2, a transfer mechanism 4, compression molding machine 6, and a take-out mechanism 8.

Above-mentioned extruder 2 contains a single extrusion die structure 10 and three heating and extrusion mechanisms

connected thereto, namely, a central heating and extrusion mechanism 12 and lateral heating and extrusion mechanisms 14 and 16. The front end of central heating and extrusion mechanism 12 is connected directly to the tail end of single extrusion die structure 10, and the molten synthetic resin sent out from central heating and extrusion mechanism 12 is fed directly to single extrusion die structure 10. The lateral heating and extruding mechanisms 14 and 16 are respectively connected to single extrusion die structure 10 via piping 18 and 20, and the molten synthetic resin sent out from lateral heating and extruding mechanisms 14 and 16 is fed to single extrusion die structure 10 via respective piping 18 and 20. This will be described with reference to Figures 2-A to 2-D along with Figure 1. The rear half portion of single extrusion die structure 10 extends substantially horizontally, but the front half portion extends downward substantially vertically (i.e., perpendicular to the viewer in Figure 1 and in the vertical direction in Figures 2-A to 2-D). An extrusion hole 22 facing downward is formed at the front end face of single extrusion die structure 10, i.e., the lower end face. The central axis of extrusion hole 22 extends substantially vertically. A molten synthetic resin flow pass (not shown) is formed inside single extrusion die structure 10, and this flow pass extends to above-mentioned extrusion hole 22. A molten synthetic resin 28 sent out from

central heating and extrusion mechanism 12 flows through the center portion of the above-mentioned flow pass and is extruded through the center portion of extrusion hole 22. Meanwhile, a molten synthetic resin 30 sent out from the two lateral heating and extruding mechanisms 14 and 16 flows around the rim portion of the above-mentioned flow pass surrounding molten synthetic resin 28 sent out from central heating and extrusion mechanism 12, and is extruded from the rim portion of extrusion hole 22. Although molten synthetic resin 30 sent out from the two lateral heating and extruding mechanisms 14 and 16 is extruded continually from extrusion hole 22, molten synthetic resin 28 sent out from central heating and extrusion mechanism 12 is extruded intermittently. Thus, as illustrated in Figures 2-C to 2-D, a molten synthetic resin 26 having a multilayer structure comprising an inside synthetic resin layer formed from molten synthetic resin 28 sent out from central heating and extrusion mechanism 12 and an outside synthetic resin layer formed from molten synthetic resin 30 sent out from two lateral heating and extruding mechanisms 14 and 16, and with substantially the entire molten synthetic resin 28 surrounded by molten synthetic resin 30 is extruded through extrusion hole 22. It is convenient that inside molten synthetic resin 28 that comprises a synthetic resin outstanding in gas barrier properties or heat resistance and the outside molten synthetic resin 30 that comprises a

synthetic resin excellent in mechanical and hygienic properties. The configuration of extruder 2 used to extrude molten synthetic resin 26 having a multilayer structure, i.e., single extrusion die structure 10 thereof may have substantially the same configuration disclosed in Japanese unexamined patent application publication no. S62-184817 above or the configuration disclosed in Japanese Unexamined Patent Application Publication No. H1-195016. Therefore, the details of this configuration are left up to the above-mentioned publications or the above-mentioned Specifications and drawings, so a description will be omitted in this Specification.

The description continues with reference to Figure 1. Illustrated transfer mechanism 4 has a rotary form in which it rotates about the rotating central axis extended substantially vertically in the direction denoted by arrow 32 in Figure 1. Transfer mechanism 4 comprises a support shaft 34 extending substantially vertically, and this support shaft 34 is equipped

/6

with four support arms 36 extending substantially horizontally and outward in the radial direction in equiangular intervals. A transferring means 38 is mounted to the respective tips of support arms 36 via an appropriate mounting mechanism (not shown) to freely move in the vertical direction. As illustrated clearly in Figures 2-A to 2-D, a receiving space 40 has a wholly

cylindrical shape and is formed upward on transferring means 38 in the extending directions, respectively. It is convenient if a recessed surface defining this receiving space 40 has a shape at least partially matching that of the surface defining the molding cavity in the female mold portion of the compression mold described later. In the illustrated specific example, the recessed surface defining receiving space 40 made into a shape matching the shape of nearly the lower half of the surface defining the molding cavity in the female mold portion of the compression mold. Moreover, it is preferred that the surface roughness of at least a portion of the recessed surface defining receiving space 40 be relatively greater by conducting, e.g., blasting, etc. The roughness of the recessed surface defining receiving space 40 may be average centerline roughness R_a of about 0.5 to 3.5 in the JIS standards. Above-mentioned support shaft 34 of transfer mechanism 4 may be an electric motor, which is intermittently rotated and driven every 90 seconds in the direction shown by arrow 32 in Figure 1 by a rotary drive source (not shown). Thus, respective four transferring means 38 are positioned sequentially in predetermined time intervals at each of a receiving position 42, standby position 44, transfer position 46, and standby position 48. As further mentioned, then at above-mentioned receiving position 42, transferring means 38 is positioned below extrusion hole 22 in above-mentioned

extruder 2 in the vertical direction, the central axis of receiving space 40 in transferring means 38 extending in the vertical direction substantially matches the central axis of extrusion hole 22, and molten synthetic resin 26 having a multilayer structure extruded through extrusion hole 22 is supplied into receiving space 40 of transferring means 38. Similarly, as further mentioned, then at above-mentioned transfer position 46, transferring means 38 is positioned below the male mold portion in the compression mold in the vertical direction, the central axis of receiving space 40 in transferring means 38 extending in the vertical direction substantially matches the central axis on the male mold portion extending in the vertical direction, and molten synthetic resin 26 having a multilayer structure is transferred to the male mold portion from receiving space 40 of transferring means 38. As illustrated in Figures 2-A to 2-D, pair of cutting blades 50 are attached to the respective tops of transferring means 38. When this pair of cutting blades 50 is moved at a predetermined timing through the intermediate position illustrated in Figure 2-C between the open position illustrated in Figures 2-A and 2-B and the closed position illustrated in Figure 2-D, and moved to the above-mentioned closed position from the above-mentioned open position, molten synthetic resin 26 having a multilayer structure extruded through extrusion hole 22 of above-mentioned

extruder 2 is cut slightly below extrusion hole 22 and is detached from exhaust pipe 22. The description will be continued with reference to Figures 2-A to 2-D along with Figure 1. An elevating mechanism 52 is disposed below transferring means 38 positioned at above-mentioned receiving position 42. This elevating mechanism 52 comprises an air pressure cylinder mechanism 54 fixed to a predetermined position at the lower end, i.e., the cylinder head end. A push-up member 56, which may have a disk shape, is fixed to the rod end of air pressure cylinder mechanism 54. By the rotation of support shaft 34, while positioning of transferring means 38 at receiving position 42, cylinder mechanism 54 contracts, a push-up member 56 is positioned at the lowest position, transferring means 38 positioned at a receiving position is positioned somewhat above push-up member 56. When molten synthetic resin 26 having a multilayer structure extruded through extruder 2 is received in receiving space 40 of transferring means 38, as further described, then cylinder mechanism 54 expands, push-up member 56 is raised, and due to the push-up operation of push-up member 56, transferring

/7

means 38 rises to the position illustrated in Figures 2-A to 2-D. After that, cylinder mechanism 54 constricts, push-up member 56 descends, and transferring means 38 descends to the position

illustrated in Figures 2-C and 2-D.

This will be described with reference to Figure 1. Above-mentioned compression molding machine 6 comprises a cylindrical stationary support shaft 58 extending substantially vertically (perpendicular to the viewer in Figure 1), and a rotating support body 60 mounted to this stationary support shaft 58 to freely rotate. Sixteen compression molds 62 are disposed at rotating support body 60 in equal intervals in the circumferential direction. A description will be continued with reference to Figures 3-A to 3-E, along with Figure 1. The respective compression molds 62 are each composed of a lower die portion, i.e., a female die portion 64 fixed to a predetermined position of rotating support body 60, and an upper die portion, i.e., male mold portion 66 mounted to rotating support body 60 to freely ascend/descend. A recess 68 opened downward in the vertical direction is formed in female die portion 64, and the surface of this recess 68 constitutes the surface defining the molding cavity. The shape of the nearly the lower half of recess 68 matches the shape of receiving space 40 in above-mentioned transferring means 38. Male mold portion 66 has a surface defining the molding cavity formed with a tapered truncated cone shape with a hemispherical tip. Above-mentioned rotating support body 60 is intermittently rotatingly driven every 22.5 degrees in the direction shown by an arrow 70 in Figure 1 by a rotary

drive source (not shown), which may be an electric motor. Thus, respective compression molds 62 are conveyed sequentially to a discharge position 76 through a compression molding region 72 from above-mentioned transfer position 46, and then to above-mentioned transfer position 46. As described in further detail, then at transfer position 46, molten synthetic resin 26 having a multilayer structure is transferred to male mold portion 66 of compression molds 62 from receiving space 40 of transferring means 38, and at compression molding region 72, by the action of compression molds 62, above-mentioned molten synthetic resin 26 having a multilayer structure is compression molded into a molded product 78 having predetermined shape (Figure 3-E), and at discharge position 76, compression molded product 78 is taken out from compression molds 62 by take-out mechanism 8.

Illustrated take-out mechanism 8 has a status wherein it is rotatingly driven intermittently in the direction shown by arrow 80 in Figure 1, and it is equipped with four take-out arms 82. An aspirator 84 able to vacuum suctions molded product 78 is equipped to the tip portion of each of arms 82. In the illustrated specific example, molded product 78 compression molded by compression molding machine 6 and discharged by take-out mechanism 8 is a so-called pre-form, as clearly illustrated in Figure 4. This pre-form is subsequently blow molded into a container 86 made of a synthetic resin for food and beverages

and the like, as illustrated in Figure 5.

Molded product 78 and container 86, which are pre-forms as such, do not constitute a novel feature in the present invention along with the aforementioned compression molding machine 6 and take-out mechanism 8 may be known figures to persons skilled in the art, and therefore, a detailed explanation of these will be omitted.

A preferred specific example of the method for compression molding of the present invention performed is described next using the compression molding apparatus as noted above.

When support shaft 34 of transfer mechanism 4 is rotated intermittently and one transferring means 38 is positioned at receiving position 42, push-up member 56 of elevating mechanism 52 is elevated to the position illustrated in Figure 2-A from the lowest position thereof, and accordingly, transferring means 38 is elevated to the position illustrated in Figure 2-A. At this time, molten synthetic resin 26 having a multilayer structure is slowly extruded, as noted above, through extrusion hole 22 of extruder 2. As clearly illustrated in Figure 2-A, the central axis of receiving space 40, which was formed in transferring means 38 positioned at receiving position 42, extending

/8

substantially vertically is substantially matched with the

central axis of extrusion hole 22 disposed at extruder 2. Therefore, the central axis of molten synthetic resin 22 having a multilayer structure extruded through extrusion hole 22 is coincided with the central axis of receiving space 40, and is extruded and flows downward in the vertical direction. Therefore, molten synthetic resin 26 having a multilayer structure is supplied sufficiently and satisfactorily to the center portion of receiving space 40 of transferring means 38 without being maldistributed. In the illustrated specific example, push-up member 56 of elevating mechanism 52 is maintained at an elevated position illustrated in Figures 2-A and 2-B until the state in which molten synthetic resin 26 having a multilayer structure is extruded through extrusion hole 22 to the extent illustrated in Figure 2-B, the tip portion of molten synthetic resin 26 having a multilayer structure comes in contact with the bottom of receiving space 40 and it starts to spread in the transverse direction along the bottom. Push-up member 56 of elevating mechanism 52 subsequently descends at a predetermined speed to the position illustrated in Figure 2-C. At this time, molten synthetic resin 26 having a multilayer structure also continues to be extruded through extrusion hole 22 of extruder 2. Thus, molten synthetic resin 26 having a multilayer structure comprising inside molten synthetic resin 28 and outside molten synthetic resin 30 substantially surrounding

entire inside molten synthetic resin 28 is supplied to receiving space 40 without being displaced in a specific direction. The form of inside molten synthetic resin 28 of molten synthetic resin 26 having a multilayer structure, in other words, the relative relationship of inside molten synthetic resin 28 and outside molten synthetic resin 30 of molten synthetic resin 26 having a multilayer structure may be appropriately controlled by regulating the time push-up member 56 of elevating mechanism 52 descends from the elevated position illustrated in Figure 2-B, or the descending speed of push-up member 56, whereby the relationship can be controlled appropriately. For example, when the descending starting time of push-up member 56 is earlier than in the illustrated case, inside molten synthetic resin 28 is finer and longer in the vertical direction than in the illustrated form. Conversely, when the descending start time of push-up member 56 is later than in the illustrated case, inside molten synthetic resin 28 is more flattened in the transverse direction than in the illustrated case. When a predetermined amount of molten synthetic resin 26 having a multilayer structure is extruded, as illustrated in Figure 2-D, pair of cutting blades 50 are moved to the closed position, extruded molten synthetic resin 26 having a multilayer structure is detached from extrusion hole 22, and thus, the predetermined amount of molten synthetic resin 26 having a multilayer

structure is supplied into receiving space 40 of transferring means 38.

When molten synthetic resin 26 having a multilayer structure is supplied into receiving space 40 of transferring means 38 positioned at receiving position 42, as described above, support shaft 34 of transfer mechanism 4 is rotated intermittently, transferring means 38 accommodating multilayer structured melted synthetic resin 26 inside receiving space 40 is moved into receiving space 40 thereof, then, support shaft 34 is further rotated intermittently, and is positioned at transfer position 46 (Figure 1). At this time, as illustrated in Figure 3-A, compression molds 62 positioned at transfer position 46 inside plurality of compression molds 62 of compression molding machine 6 are opened. That is to say, male mold portion 66 of each of compression molds 62 is elevated upward in the vertical direction and detached upward from female die portion 64. Transferring means 38 carried in to transfer position 46 is positioned between female die portion 64 and male mold portion 66, and the central axis of receiving space 40 formed in transferring means 38 extended substantially in the vertical direction is substantially matched with the central axis of male mold portion 66 positioned above it extending substantially vertical. Next, as illustrated in Figure 3-B, male mold portion 66 descends a predetermined distance, and thus, molten synthetic

resin 26 having a multilayer structure accommodated inside receiving space 40 of transferring means 38 is forced into male mold portion 66 at a considerably smaller pressure than the compression molding pressure. Although molten synthetic resin 26 having a multilayer structure is deformed by this

/9

forcing, molten synthetic resin 26 having a multilayer structure is deformed to a predetermined shape (namely, the shape along surface of male mold portion 66) without generating drifting in a specific direction of inside melted synthetic resin 28 because the central axis of receiving space 40 formed in transferring means 38 and the central axis of male mold portion 66 substantially coincide with one another, as noted above. Male mold portion 66 subsequently ascends, as illustrated in Figure 3-C. Because the adhesive power between molten synthetic resin 26 having a multilayer structure and the surface of receiving space 40 is smaller than the adhesive power between molten synthetic resin 26 having a multilayer structure and male mold portion 66, molten synthetic resin 26 having a multilayer structure attaches to male mold portion 66 when male mold portion 66 ascends, ascends along with it, and thus is moved to male mold portion 66 from receiving space 40 of transferring means 38. AS illustrated clearly in Figure 3-C, inside molten synthetic resin 28 of molten synthetic resin 26 having a

multilayer structure moved to male mold portion 66 is present in the center portion of outside molten synthetic resin 30 without being maldistributed in a specific direction. Since the adhesive power between molten synthetic resin 26 having a multilayer structure and receiving space 40 is sufficiently lower than the adhesive power between molten synthetic resin 26 having a multilayer structure and the surface of male mold portion 66, in the illustrated specific example, the surface roughness of at least a portion of the surface of receiving space 40 is considerably increased by conducting, e.g., blasting thereon, as mentioned above. For example, when average centerline roughness R_a of the surface of male mold portion 66 is 0.1 or less according to JIS standards, average centerline roughness R_a of the surface of receiving space 40 should be set to about 0.5 to 3.5. The transfer of molten synthetic resin 26 having a multilayer structure to male mold portion 66 from receiving space 40 of transferring means 38 must be pre-formed smoothly enough; hence, it is preferable to control the temperature of receiving space 40 until molten synthetic resin 26 having a multilayer structure is transferred from extruder 2 to male mold portion 66 after it is received to about 10 to 50˚C. This temperature control can be performed by forming an appropriate heat medium circulation path (not shown) in transferring means 38, and allowing an appropriate eating medium to flow through

this circulation path. When molten synthetic resin 26 having a multilayer structure is transferred to male mold portion 66 from receiving space 40 of transferring means 38, instead of or in addition to lowering male mold portion 66, transferring means 38 is elevated by an appropriate elevating means, as desired.

When molten synthetic resin 26 having a multilayer structure is transferred to compression molds 62 from transferring means 38 at transfer position 46, as described above, support shaft 34 of transfer mechanism 4 is rotated intermittently, and transferring means 38 present at transfer position 46 moves to standby position standby position 48 and then support shaft 34 is further rotated intermittently and is moved to receiving position 42. Meanwhile, compression molds 62, of chain 66, to which molten synthetic resin 26 having a multilayer structure was supplied is carried through compression molding region 72 in association with the rotation of rotating support body 60, and then is carried through discharge position 76. When it is carried through compression molding region 72, male mold portion 66 slowly descends and closing of the mold is performed, as illustrated in Figures 3-C, 3-D, and 3-E, and molten synthetic resin 26 having a multilayer structure is compression molded into the necessary molded product 78. In the improved method for compression molding according to the present invention, molten synthetic resin 26 having a multilayer structure is supplied

into receiving space 40 of transferring means 38, as mentioned above, without generating bias, and this molten synthetic resin 26 having a multilayer structure is transferred to male mold portion 66 of compression molds 62 without generating bias. Therefore, inside molten synthetic resin and outside molten synthetic resin exist sufficiently and uniformly dispersed, as required, in compression molded product 78 without being biased. When

/10

compression molds 62 is moved to discharge position 76, male mold portion 66 is elevated, mold-opening is performed, and molded products 78 are taken out of compression molds 62 at discharge position 76 by the action of take-out mechanism 8, as already stated.

Thus, in the aforementioned specific example, molten synthetic resin 26 having a multilayer structure extruded through extrusion hole 22 of extruder 2 has a multilayer structure in a form wherein substantially all of inside molten synthetic resin 28 is surrounded by outside molten synthetic resin 30, but the present invention is not limited to a multilayer structured molten synthetic resin having such a form; it may be applied to cases of a single-layer structure molten synthetic resin comprising only one molten synthetic resin, a multilayer structured molten synthetic resin having a form in

which outside molten synthetic resin surrounds only the flanks thereof not the entire inside molten synthetic resin, etc. A multilayer structured molten synthetic resin having a form in which outside molten synthetic resin only surrounds the flanks of inside molten synthetic resin is described in detail in the Specification and drawings of Japanese Patent Application No. S63-250943 (application date: October 6, 1988; title of invention: Method for Manufacturing Compression Molding Having Multilayer Structure) pertaining to the application of these applicants; hence, this description is cited and a description is omitted in this Specification.

(Working Example and Comparative Examples)

Working Example

The compression molding apparatus having the form as described with reference to Figures 1, 2-A to 2-D, and 3-A to 3-E was used to multilayer structured molten synthetic resin through the extrusion hole (inner diameter: 22 mm) of the extruder first and then supply it into the receiving space of the transferring means. The supplied multilayer structured molten synthetic resin comprises nearly 3 g of the inside molten synthetic resin comprising EVAL (viscosity index MI: 6.5) that is commercially-available from Kuraray Co., Ltd.), and an outside molten synthetic resin comprising polyethylene terephthalate (limiting viscosity IV: 0.7) that is commercially-

available from Mitsui Petrochemical Industries, Ltd., with the total amount being 40 g. The temperature during extrusion of the outside molten synthetic resin was 290˚C. The average extrusion speed was 4.4 mm/sec and the spacing between the extrusion hole and the lowest surface of the receiving space of the transferring means [misspelled in original] was 40 mm when extrusion started, while the above-mentioned spacing about 2 seconds after extrusion started was 30 mm, then the above-mentioned spacing was 40 mm after about 1 sec, and the multilayer structured molten synthetic resin extruded was cut by the pair of rotary blades.

Next, the transferring means accommodating the multilayer structured molten synthetic resin inside the receiving space thereof is moved to the transfer position where it is positioned below the male mold portion of the opened compression mold. Next, the male mold portion descends, whereby the multilayer structured molten synthetic resin in the receiving space is forced to the surface of the male mold portion. The descending speed of the male mold portion was 40 mm/sec, and the pressing force between the male mold portion and transferring means was nearly 100 g. After that the male mold portion ascended at an ascending speed of 40 mm/sec, and the multilayer structured molten synthetic resin was transferred to the male mold portion from inside the receiving space of the transferring means. The

surface roughness of the male mold portion was an average centerline roughness R_a of 0.03, and the centerline roughness R_a of the recessed surface defining the receiving space formed in the transferring means was 2.3. The temperature of the recessed surface defining the receiving space of the transferring means was controlled to a range of from 20 to 40˚C. Next, the pre-form was compression molded, as illustrated in Figure 4. The inner diameter of the molded pre-form at the upper end portion was 57 mm and the thickness of the main part excluding the upper end portion was 3.7 mm, while the height was 62 mm. The molded pre-form was thoroughly observed, whereupon the inside molten synthetic resin inside the outside molten synthetic resin was extended remarkable uniformly and there was substantially no strain according an optical observation. Moreover, no crease developed in the surface of the pre-form at all, and the extent of creasing according to JIS standards was

/11

0.6 μm denoted by a wave centerline waviness W_{ca}.

The above-mentioned pre-form was blow molded into the wide-mouthed container illustrated in Figure 5 by the usual system. In this blow molding, an attractive container could be molded, as required, without generating any inconveniences, such as tilting of the pre-form, during heating of the pre-form.

<u>Comparative Example 1</u>

For comparison, except for the form of the transferring means as disclosed in the Specification and drawings of above-mentioned Japanese Patent Application No. S63-286801, being eliminated, a pre-form was compression molded in the same method as the working example. When the compression molding was repeatedly performed, it was confirmed that the tendency for the inside molten synthetic resin to be maldistributed inside the male mold portion increased gradually. Moreover, when a slight crease developed in the surface thereof, the extent thereof was 10 μm as denoted by the wave centerline waviness W_{ca} according to JIS standards. This pre-form was blow molded to mold a container, and upon observing its surface, a somewhat defective appearance was recognized.

Comparative Example 2

For further comparison, as illustrated in Figure 6, an extrusion hole 222 was opened in substantially the horizontal direction, an extruder 202 whose central axis extended substantially horizontally in extrusion hole 222 was used to extrude molten synthetic resin 26 having a multilayer structure6 through extrusion hole 222 of extruder 202, this was cut by a rotary cutting blade 224, and then supplied directly into a female mold portion 264 positioned beneath extrusion hole 222. The inner diameter of extrusion hole 222 was 31.5 mm, and the spacing between the central axis of extrusion hole 222 and the

lowest portion of the surface of female mold portion 264 defining the mold cavity was 110 mm. Another point similar to that of the working example is that a pre-form was compression molded. Upon observing this entire pre-form, and at the same time, cutting it in the axial and transverse directions, inside molten synthetic resin existed biased at a site at a specific angle (site corresponding to the left side portion of female mold portion 264 in Figure 6), and could not possible be satisfactory.

4. Brief Description of the Drawings

Figure 1 is a simplified plan view showing the compression molding apparatus used to perform the ideal specific example of the method for compression molding of the present invention.

Figures 2-A, 2-B, 2-C, and 2-D are partial cross sections showing a schema in which the multilayer structured molten synthetic resin is supplied to the transferring means in the compression molding apparatus of Figure 1.

Figures 3-A, 3-B, 3-C, 3-D, and 3-E are partial cross sections showing a schema in which the multilayer structured molten synthetic resin is transferred from the transferring means in the compression molding apparatus of Figure 1 to the compression mold, and a schema in which the multilayer structured molten synthetic resin is compression molded in the compression mold.

Figure 4 is a cross section showing the pre-form compression molded using the compression molding apparatus of Figure 1.

Figure 5 is a side view showing a container blow molded from the pre-form of Figure 4.

Figure 6 is a partial cross section showing a schema of the multilayer structured molten synthetic resin in Comparative Example 2.

2: Extruder

4: Transfer Mechanism

6: Compression Molding Machine

8: Take-Out Mechanism

22: Extrusion Hole

26: Multilayer Structured Molten Synthetic Resin

28: Inside Molten Synthetic Resin

/12

30: Outside Molten Synthetic Resin

38: Transferring Means

40: Receiving Space

50: Cutting Blades

52: Elevating Mechanism

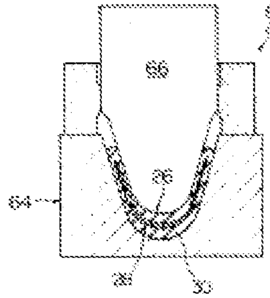
62: Compression Molds

64: Female Die Portion

66: Male Mold Portion

78: Compression Molded Product

Figure 3-D Figure 3-E



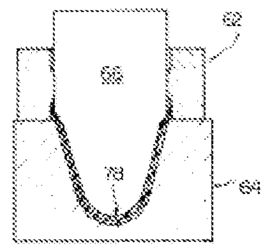
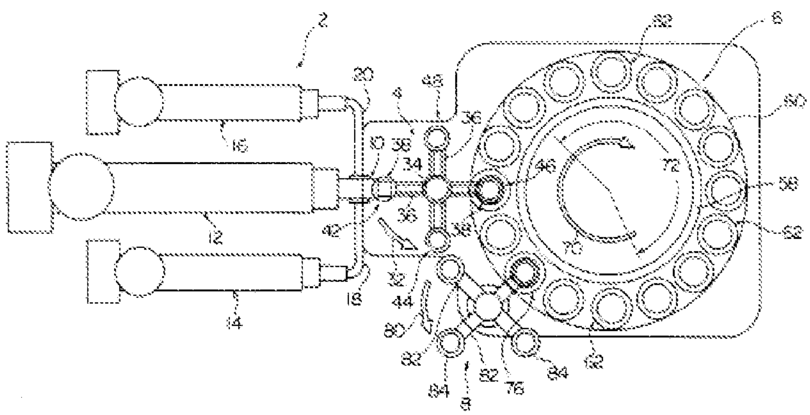
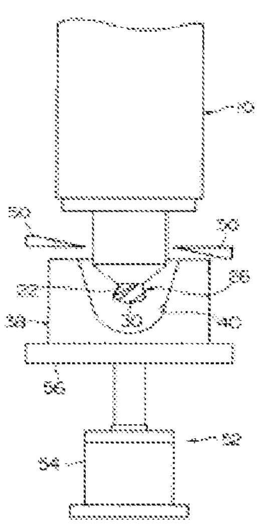


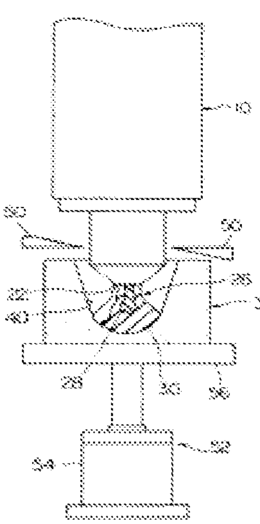
Figure 1

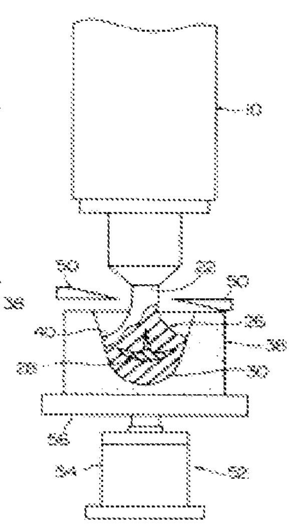


/13

Figure 2-A Figure 2-B Figure 2-C Figure 2-D







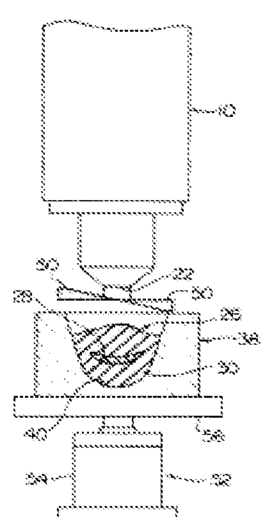
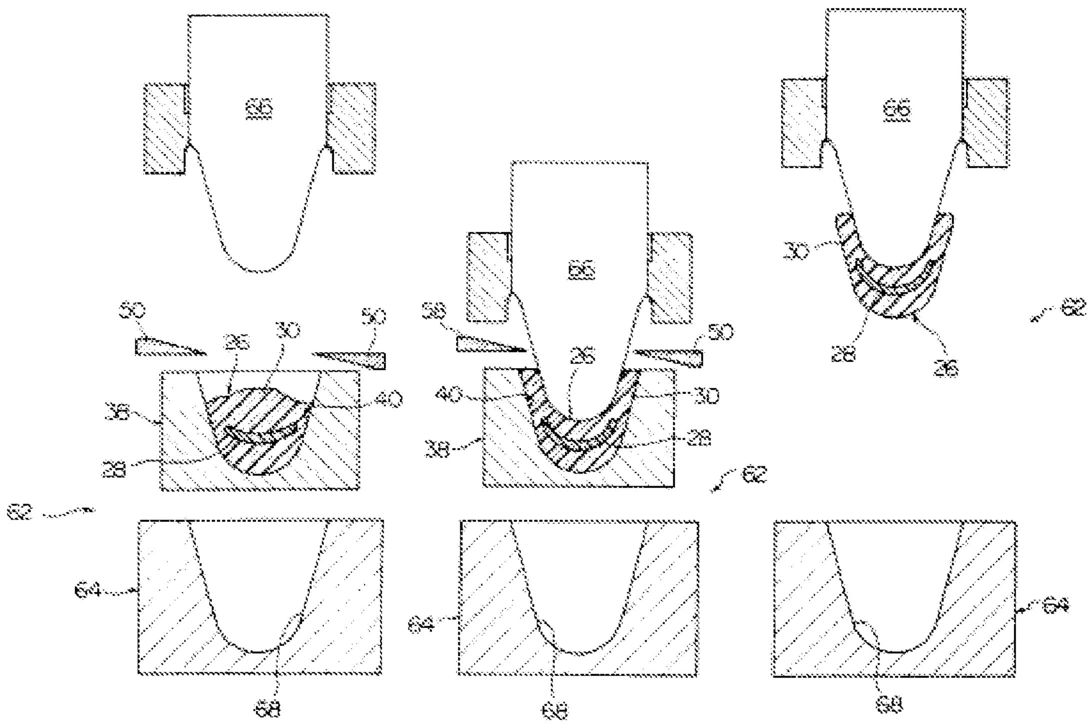


Figure 3-A Figure 3-B Figure 3-C



/14

Figure 4

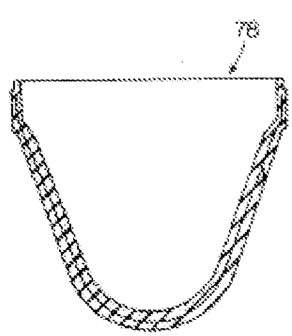


Figure 5

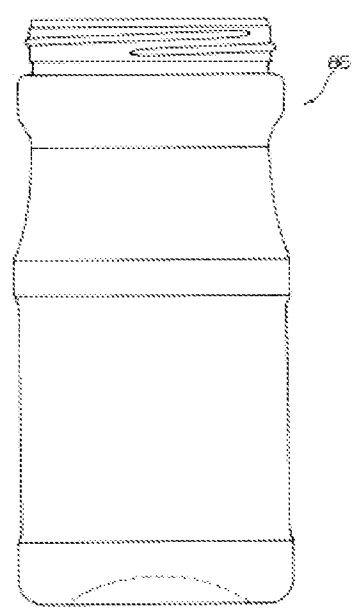


Figure 6